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Estimating Upper-Stem And Limb-Wood Volume In Northeastern Hardwoods

In the nationwide forest survey being made by the U.S. Forest Service, one of the items required is the cubic-foot volume in limbs of hardwood trees. Pulp companies and others have shown interest in this kind of information.

The problem is to measure these volumes. The diameters of limbs high up in the tree are difficult to estimate; and in summer the leaves obscure them and make estimates almost impossible. So we turned to woods-utilization studies to get more accurate data on both upper-stem and limb-wood volume. From trees that lay on the ground precise measurements were possible.

From measurements made in these woods-utilization studies, factors have been developed relating upper-stem[1] and limb-wood[2] volume to the board-foot volume (grade material) of hardwood sawtimber trees of various height classes. Likewise, limb-wood volume has been related to total growing stock volume of hardwood sawtimber trees. Height classes were determined by the top of the last grade log, rather than the height to 8 inches diameter inside bark.

Data were available for 314 trees located in Pennsylvania, New York, New Jersey, Massachusetts, New Hampshire, Maine, and Connecticut. The size of sample did not warrant breaking down data by species or species groups. As additional data become available from regular woods-utilization

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[1]Upper-stem volume includes volume of main stem from top of uppermost grade log to a minimum 4-inch diameter inside bark or to the point where the main stem breaks up into limbs.

[2]Limb-wood includes volume of all limbs over 2 feet long to a minimum 4-inch diameter inside bark.

studies or special studies, these factors may be revised and broken into groups according to limbiness of trees.

Certain hardwood species seem to develop considerably greater limb-wood volume, in relation to the main-stem volume, than do other species. Available data indicate that hickory, paper birch, red maple, white ash, and basswood are species with relatively light limb-wood volume--less than 80 cubic feet of limb wood per 1,000 cubic feet of growing stock. Species with medium limb-wood volume--80 to 149 cubic feet of limb wood per 1,000 cubic feet of growing stock--include yellow-poplar, black gum, white oak, red oak, black birch, sugar maple, black cherry, and beech. Only two species, elm and yellow birch, had 150 or more cubic feet of limb wood per 1,000 cubic feet of growing stock.

Table 1.--Volume in upper stem and limb wood of hardwood sawtimber trees

Trees in sample (Number)	Height class[1]	Limb wood per M cu.ft. of growing stock	Upper-stem volume per M bd.ft. of sawlog volume[1]	Limb-wood volume per M bd.ft. of sawlog volume[1]	Upper-stem and limb-wood volume per M bd.ft. of sawlog volume[1]
	16-foot logs	Cubic feet	Cords	Cords	Cords
28	1	211	1.12	0.80	1.92
91	1½	136	.68	.42	1.10
116	2	114	.46	.33	.79
59	2½	101	.34	.27	.61
20	3+	89	.23	.21	.44
314	All	121	0.49	0.35	0.84

[1]Includes only that material in sawtimber trees that meets minimum specifications for factory or structural logs.

Table 1 shows the cubic feet of limb wood per 1,000 cubic feet of growing stock, and the cords of upper stem and limb wood per 1,000 board feet of sawlog volume in hardwood sawtimber trees. Board-foot volume was computed on the basis of individual logs, 16-footers where possible--otherwise to the nearest whole foot. Cubic-foot volume of upper stem and limb wood was computed from tables based on Smalian's formula for securing volume of paraboloid frustrums.

Sampling errors for the estimates of cords of upper stem and limb wood combined per 1,000 board feet of sawlog volume were computed to range between 4.6 and 11.2 percent.

--WAYNE G. BANKS and FREDERICK E. HAMPF

Division of Forest Economics
Northeastern Forest Experiment Station
Forest Service, U.S. Dept. Agriculture